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IRON AGE

OCTOBER 17, 1986

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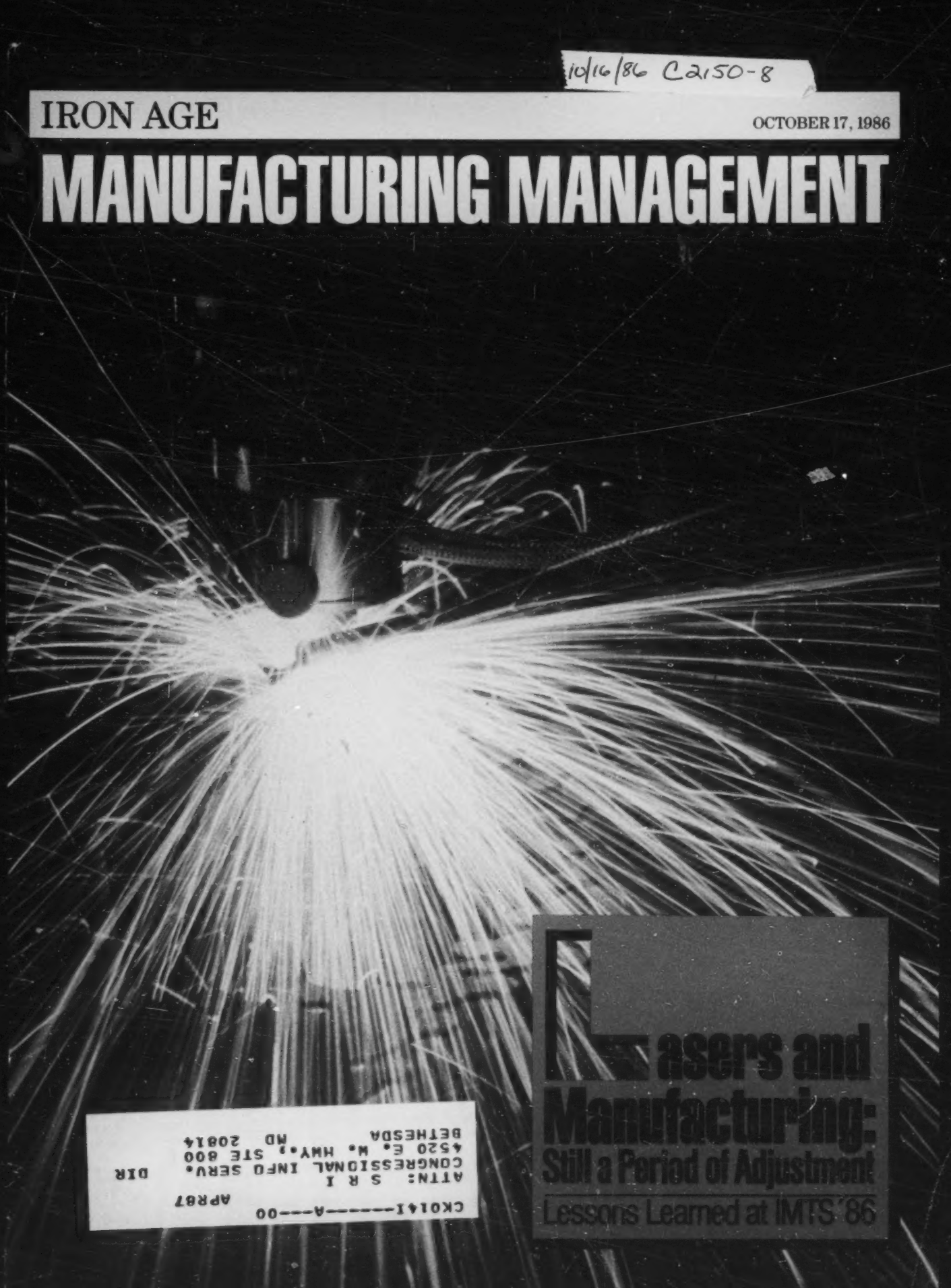

Lasers and Manufacturing: Still a Period of Adjustment

Lessons Learned at IMTS '86

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OCTOBER 17, 1986 VOL. 229, NO. 20

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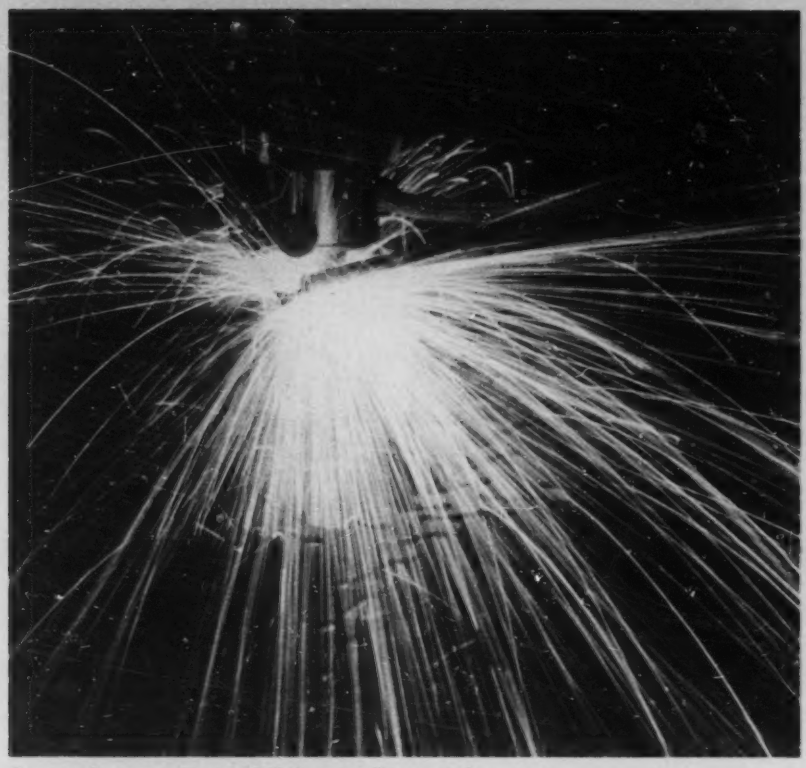

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IRON AGE (USPS 269-780) is published 24 times a year by CHILTON COMPANY, Chilton Way, Radnor, PA 19089. Chilton Co. is a division of American Broadcasting Companies, Inc., New York, N.Y. Second Class Postage Paid at Wayne, PA 19087 and additional mailing offices. IRON AGE is sent on a controlled free basis to qualified managers in U.S. metalworking companies. All others: Manufacturing Management edition—$52 one year, $85 Canada/Foreign (24 issues). Metalsproducer edition—$30 one year, $56 Canada/Foreign (12 issues). Single copies, $3.00. Cable: Chilton, Philadelphia.
Send address changes to IRON AGE, P.O. Box 2040, Radnor, PA, 19089.

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Lasers and Manufacturing: Still a Period of Adjustment

Although industrial lasers have been around for a quarter of a century, they have yet to be welcomed with open arms on the factory floor.

This Laser Cutting Center for Spectrum Laser Corp., Wheeling, Ill., employs a Photon Sources, Inc., laser to provide precise cutting accuracies.

BY ROBERT E. HARVEY

The promise of industrial lasers, so long so bright, remains tantalizingly out of reach.

That is not to say that lasers are not being used on the shop floor. They are—in growing numbers. Aerospace firms, automotive companies, and electronics manufacturers in particular are finding increasing uses for the marking, heat treating, cladding, cutting, drilling, and welding capabilities of lasers. Reportedly, more than 6,000 material-working lasers are now in operation.

However, until now, sales have been sporadic and below expectations. The laser industry still hasn't hit its stride. The period of adjustment between lasers and manufacturing drags on and on.

Disappointing sales have not been due to a lack of potential applications. "In just about any manufacturing plant I can find at least one application that can best be handled by a laser," observed William H. Shiner, vice president sales and marketing, Coherent General, Sturbridge, Mass.

Nor is the high initial cost of laser systems the principal deter-

rent. If prices were exorbitant, laser sales to small job shops would not be on the rise.

Since the laser is not a traditional manufacturing tool, the biggest obstacle to its acceptance has been ignorance of its possibilities. Erase this ignorance and laser sales will soar—or so laser suppliers assumed.

Well, ignorance is fading. Skepticism as to the usefulness of industrial lasers is dissipating. The laser has become recognized as a effective manufacturing tool. Yet this new awareness has not opened factory doors as wide as expected.

If lasers are such valuable tools, why aren't plants snapping them up? The reasons are many, but the most prominent one, the one laser suppliers thought they had licked, remains ignorance.

"If process engineers now recognize the availability of laser technology and now know something about it, there are still very few with specific knowledge of what a laser can do," noted Michael Laird, vice president, marketing, International Laser Machines Corp. (ILM), Indianapolis, Ind., a recent acquisition of Cincinnati Milacron, Inc., Cincinnati.

Engineers Uncertain

Although lasers are versatile, each has a particular profile. Each application has its own characteristics as well. Each demands a particular laser wave length, energy level, beam profile, and beam modulation signature.

Although he or she knows about lasers generally, too often the process engineer does not know if a particular laser will cut $^1/_4$-in. type-304 stainless steel, produce the edge that's needed, or the 300 parts by four o'clock.

"It all gets back to education," continued Mr. Laird: "on-the-job training, in-house training. It also gets back to good competitive intelligence, learning how related industries are using lasers.

"Automotive companies are using a lot of lasers. If other fabricating industries were really on the ball, doing competitive intelligence, they would be looking at how a car gets cut, trimmed, and welded by lasers. If lasers can do those things to a car, why not a toaster or tractor."

To produce better informed engineers and machinists, trade schools and universities should sharpen their focus on lasers. Also needed are standard, codified tests or benchmarks to make it easier to compare lasers with lasers and with other equipment.

Currently, too many laser companies service the marketplace. Some are doing well, others are breaking even, but many are struggling.

If specific knowledge of and confidence in lasers are slow in coming, they are coming.

"The automotive industry is accustomed to buying production equipment from the conventional automation houses," said Coherent General's Mr. Shiner. "What has happened over the past few years is that these houses have taken an interest in lasers. They are putting the stamp of credibility on laser technology. A lot of companies that would never buy from a laser company are comfortable with a laser from an automation supplier."

According to Mr. Shiner, laser sales have grown slowly because not only has the end user had to be educated but the production equipment suppliers as well.

For laser usage to take off, a critical mass usually must be reached. After a certain number of companies in an industry buy lasers, purchases throughout the industry escalate rapidly due to competitive pressure. So far, only a few industries have reached that stage. But laser suppliers are confident that this point will be attained in a number of niche markets soon.

Also slowing laser sales are old-fashioned cost accounting methods. Using these methods makes justification difficult.

It is instructive to see why most laser purchases are made. Frequently, a laser is purchased to perform one task, usually a high volume operation. Typically, a laser is justified by the amount of throughput it can generate. In contrast, laser job shops are springing up throughout the U.S. They are buying lasers for flexibility, not speed.

It is curious that on one hand lasers are being purchased for dedicated high-output jobs, while on the other they are being bought to do a wide variety of small batch production operations.

Production in most companies, however, falls somewhere between the low-volume job shop and the dedicated factory. Because a laser fits well into both the job-shop and the high-production environment, it would seem that it would be ideal for average shop which requires both flexibility and dedication. But such is not the case.

Antiquated Accounting

These mid-volume firms have not seen the light, so to speak, because of accounting practices. It is difficult with present accounting methods to figure the cost of inflexibility. With a dedicated line, management can count pieces per hour and the number of people on the line to easily determine operating costs. But figuring the cost of job-shop operations, particularly in a large plant, is extremely difficult.

"Until companies get a better understanding of the enormous cost that they bear by having parts sitting around weeks before they are processed, they will find

it very difficult to justify the economics of a laser," said Mr. Laird. "In other words, figuring out how much inflexibility really costs is tough to get a handle on.

"By way of contrast, the job shop deals with that problem every day. And though the shop might not be able to justify operations down to the last decimal, it recognizes the need for the flexibility to move quickly from one job to the next."

Another obstacle to increased sales is the high cost of an industrial laser. A laser machining center, for example, can cost over $200,000. Typically, a laser arrives as part of a custom system. So not only must a laser be purchased but all the attendant controls, software, hardware, and engineering as well.

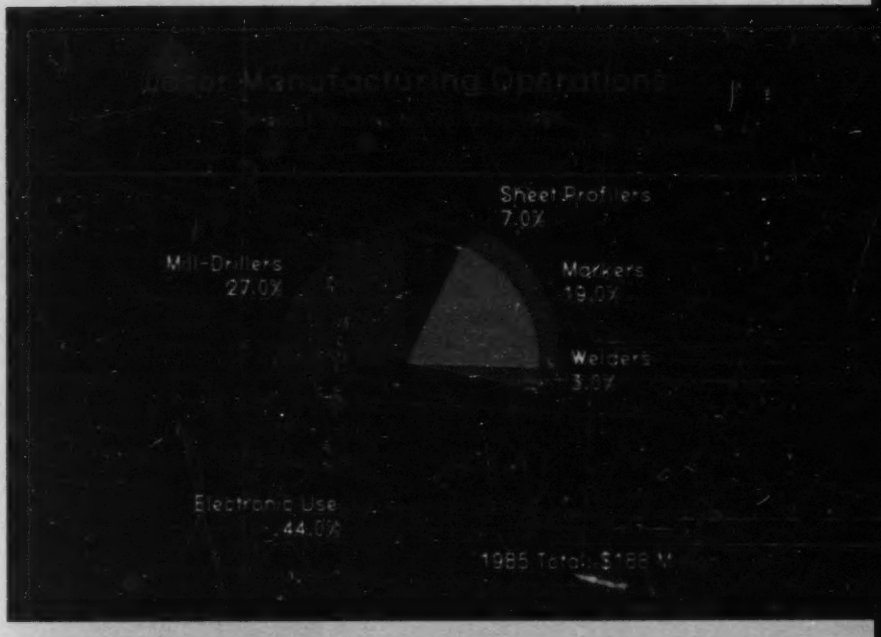
Since laser systems don't come cheap, laser suppliers and manufacturers have worked hard at trimming costs.

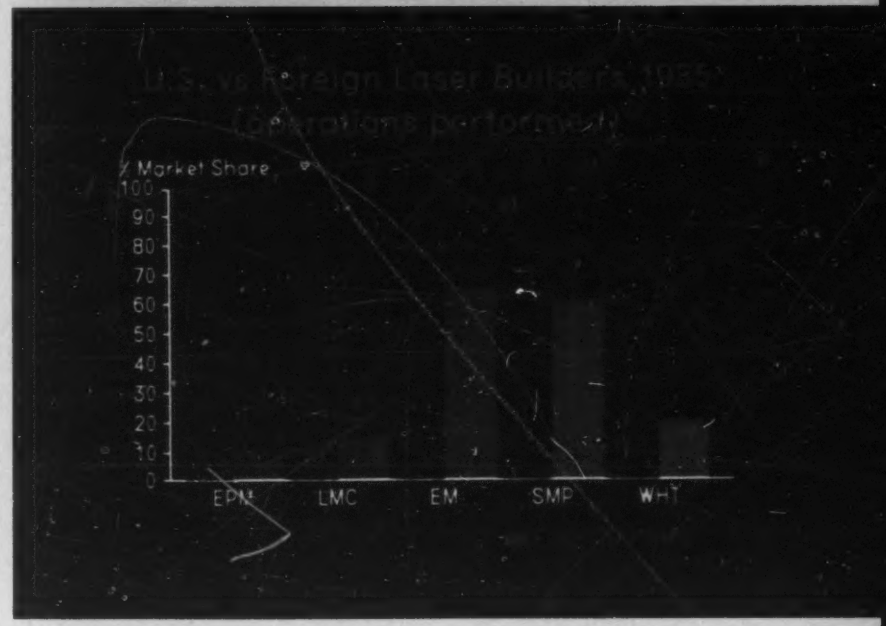
"Without a doubt, lasers represent a price-sensitive market. On the other hand, it is still a high technology, high engineering content product. There is still a need to pay for the high engineering overhead and the inherent risk associated with the business," explained Mr. Laird. "Over time that situation is going to change in favor of a consumer. I think significant price reductions will occur gradually over the next five to seven years."

Most laser makers agree that low volumes, more than any other factor, are responsible for high costs. However, another reason is the high cost of R&D, particularly R&D for laser redesign to meet changing factory needs.

"The first lasers that were introduced to industry," explained Mr. Shiner, "were easy to justify because they were doing applications that, number one, couldn't be done any other way, or, number two, involved expensive parts which could be turned out rapidly with lasers.

"As lasers get into more mundane applications, they must be redesigned for new demands."





EPM: electronic production machines; LMC: laser machining centers; EM: engraver/markers; SMP: sheet metal profilers; WHT: welding/heat treating.

The laser industry initially serviced aerospace needs, machining expensive parts and exotic materials. Now it is moving into automotive and related industries. "Now that we are competing—and doing very well—against conventional techniques, reliability and servicability has got to improve," said Mr. Shiner.

Currently, too many laser companies service the marketplace. Some are doing well, others are breaking even, but many are struggling. Expected industry

failures and consolidations should bring about higher volumes for the survivors. And higher volumes should mean lower costs. The continuing drop in computing power should help keep costs down for laser systems as well.

The industry is already undergoing something of a shake up. As mentioned, ILM was recently purchased by Cincinnati Milacron. ILM is to be a wholly-owned subsidiary of Milacron. Milacron had been combining lasers with its industrial robots and integrating them into flexible manufacturing systems.

The company decided to get more heavily involved with lasers because: "Lasers to process materials are becoming a very important manufacturing technology in virtually all the industries that Milacron serves," said James Geier, chairman. "They have many applications in metalworking and in processing both plastics and composite materials."

Industry Shakeup

Elsewhere, C-E Industrial Lasers, Inc. (CEIL), a subsidiary of Combustion Engineering, Inc., Stamford, Conn., purchased Koppers Laser Systems Div., Westminster, Md., in a move, say officials, to further enhance C-E's overall systems approach to the industrial laser market.

Koppers Laser Systems makes a line of CO_2 lasers and laser processing centers. The centers consist of: machine tool components for work piece manipulation, beam delivery systems, and integrated CNC controls which interface with almost any laser. "These systems are important because of the critical interface between the laser and the workstation. It is often the weak link in the laser-based system," said CEIL President Charles McGough.

Virtually every laser system sold is a customized product. Some laser companies, though, see a different route to profitability. They plan to get out of the customized systems business (with its high engineering overhead) and target laser sales at OEMs and systems houses that will incorporate lasers into their products. By leaving behind the custom engineering work, some believe, they can concentrate on what they do best: laser design and development. However, other laser firms see problems with this approach.

Money can be made selling systems, insists Donald Hoffman, marketing manager, Raytheon Co. Laser Products, Burlington, Mass. "The trick is that you develop a series of standard modules. The more systems you build, the more modules you have, and we build a lot of systems. Whenever we design a system, we ask how much standard equipment can be put in. Maybe the laser is going to be standard; the CNC controls are probably going to be standard; the tables are probably going to be standard; and maybe some degree of beam motion is going to be standard. Perhaps when completed, only 10 or 20 pct of this custom

An auto supplier uses the Wiedemann Centrum Laser, a high-precision, computer-controlled fabricating system, to cut engine gaskets from sheet metal.

system needs to be customized."

Despite the sputtering demand for lasers in general, demand in certain areas is growing. Laser marking, for example, is generating a great deal of interest.

"The military has mandated that virtually everything will be serialized," explained Mr. Hoffman. "Take the new Beretta pistols that the Army plans to buy. Each pistol will be laser marked and every part in every pistol will be laser marked. In the automotive industry as well, the new anti-theft programs are requiring that certain critical parts will be laser marked. The applications go on and on."

Marking a part can be done with a number of tools, many a lot cheaper than a laser. However, laser marking, which has been around for a decade, has some advantages over techniques like ink printing, hot stamping, and others. Laser marks cannot be smeared, washed or rubbed off, or burned off during heat treating. Lasers also offer speed, ease of use, and flexibility.

Permanent History

Increasingly, the military, aircraft manufacturers, and auto makers are requiring a permanent history of critical manufactured parts. If a plane crash results from a part failure, for example, officials want to be able to track the history of that part back to its origins: the place where it was made, when, and by whom. Indelible bar codes, alphanumerics or other symbols etched on the part by a laser during manufacture can provide that information.

Raytheon's marking laser, EnduraMark, can etch a multitude of bar codes as well as script and gothic writing styles. As options, it has a mouse and can be tied into a CAD/CAM system. It has a writing speed of almost 100 in./sec and can operate over a 36 sq in. marking area. Reportedly, it is easy to use and reprogram.

Besides using marking to trace the history of a part after that part has left the factory, manufacturers are using marking, particularly bar coding, as an integral part of factory automation efforts. Increasingly, companies want to track the status of parts and operations automatically. Bar coding, OCR and vision systems permit this tracking. Marking lasers are central to many automated tracking operations.

"Customers are interested in using bar codes to track products through their manufacturing process," said Mr. Laird. "The problem is that bar codes are not a very consumer-friendly method of identification. They can't be read with the human eye. One customer of ours is considering installing a system at a final step in his manufacturing process that will read bar code with a laser scanner and then dump that information into our laser marker. Then the marker will write in English a description of the part and other required information."

Laser Job Shops

As mentioned earlier, laser job shops are on the increase. And even job shops specializing on laser marking are appearing. These marking specialists are having the greatest success servicing the electronics, jewelry, and medical industries.

"Besides marking, another area that appears to be strengthening is laser drillers for jet engines," noted Don Hoffman of Raytheon.

But much of the growth of laser use remains in the future.

Laser welding, for example, has a great deal of potential. "But the welding function is growing much more slowly than the rest of the industry," said Mr. Laird. "The laser produces a very superior weld. But it requires superior fixturing to make that happen. The laser beam is probably the best at creating a weld bead with high integrity. It is one of the few technologies for welding dissimilar metals together. Its disadvantage is that the spot size, by necessity, has to be quite small; that means fixturing becomes very critical."

Right now it is costly to get a part precisely fixtured in order to have a successful weld time after time. But this problem could soon be overcome.

"At present, the automotive industry tends to go with oversize lasers because part tolerances cannot be held tightly enough," said Mr. Shiner. "But two trends are converging: the automotive industry is driving toward more accurate parts control, while laser companies are working on developments like seam tracking and automatic focus to increase accuracies. These trends should come together in about three years."

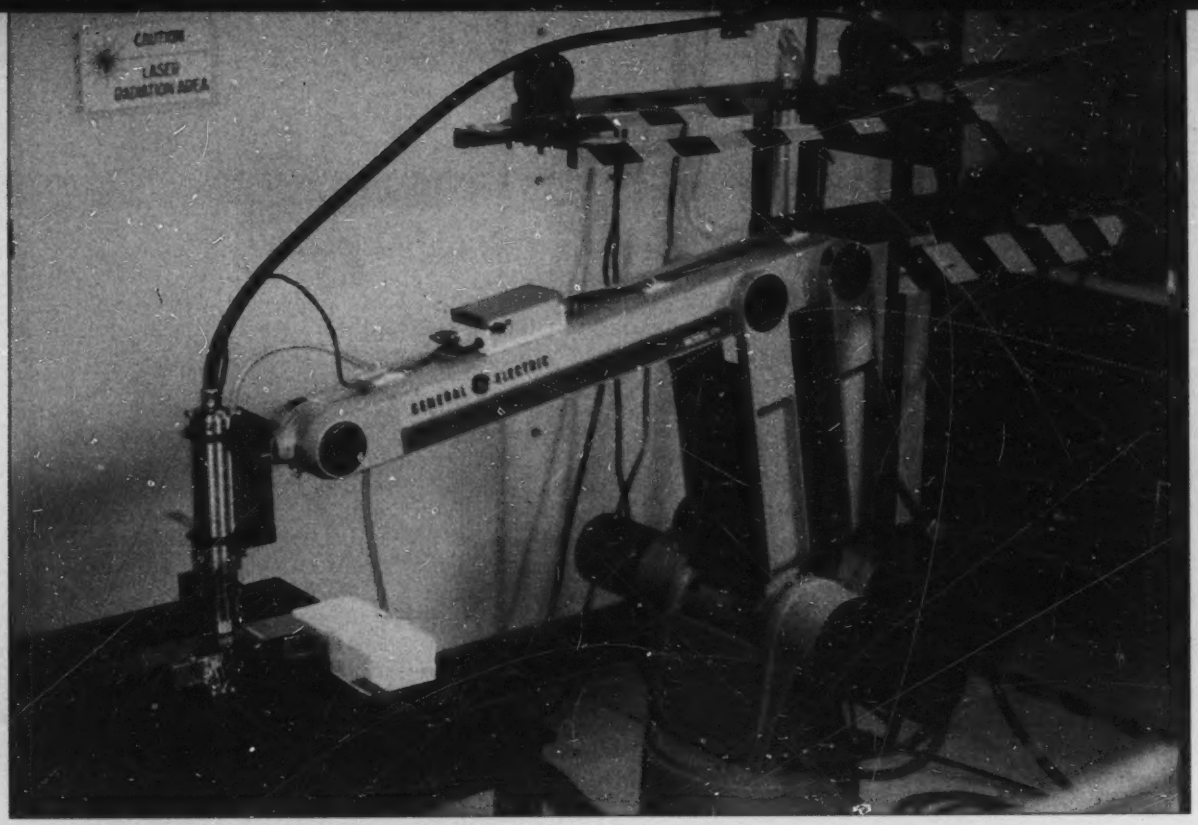
Trends suggest the installation of 25,000 material working lasers by the year 2000, reports Fred Seaman, manager, Laser Center, IIT Research Institute, Chicago. Some of the major growth areas that will accelerate in the next few years will be the increased use of lasers for metallurgical operation such as heat treating, cladding and alloying, and the further inclusion of lasers in flexible manufacturing systems, says Mr. Seaman.

Heat Treating Growing

Although right now a small percentage of laser applications involve heat treating, the potential is there for strong growth. Laser heat treatment acts much like induction hardening except: "Rapid cooling after laser heating can often be accomplished without resorting to distortion-producing quench baths or sprays," said Mr. Seaman at the SME Lasers in Manufacturing: SPOT '86 Conference last May in Philadelphia. "In addition, hardening can be accomplished deep inside cavities in the work piece or while the part is still held in a machine tool.

"And finally, hardened zones can be formed in precise, complex shapes located exactly where they are needed, so that the effect of heating on part precision can be held to a minimum."

These qualities, noted Mr. Sea-



Mounted on a GE robot is a laser from Coherent General Corp., Sturbridge, Mass.

man, make lasers an attractive competitor to any traditional heat treating operation aimed at achieving a hard surface on steel or cast iron, particularly if the hardened surface is required only at selected places.

Laser heat treating is growing at a slow rate right now, said Mr. Laird. But it will begin to change when designers begin rethinking the way they design products.

Laser heat treating will always be one of the most expensive ways to heat treat because of the inherent inefficiencies of converting electricity to laser light. For laser heat treating to be effective, designers must think about the minimal amount of heat treating necessary for a part—particularly a part with complex surfaces—to function properly.

Another area of potential growth involves the integration of lasers and conventional metal and other material working processes into one system.

"Since the mid-1970s, lasers have been integrated with NC turret punch presses," noted Mr. Seaman, "but other uses are opening up for laser integration. Studies indicate the benefits of laser beams on the removal of metal in single-point turning operations."

By heating the metal during the machining operation, removal rates were increased in some cases by as much as 50 pct, while tool wear was decreased and surface finish improved. Hard to machine materials such as titanium alloys have been more easily machined with the assistance of a laser. If able to assist in machining hardened steel work pieces, laser assisted machining could replace some grinding operations.

Lasers are not only assisting material working machines but robots as well. Sales of laser robots have not been spectacular. The high cost of the robot plus the high cost of the laser makes the combination difficult to justify. Another concern is the inaccuracies and lack of speed of the robot.

Besides assisting machine tools in punching and turning operations, lasers in years to come could add flexibility to a variety of manufacturing cells.

ILM has developed what it believes is the first flexible cell composed entirely of lasers. The cell, made up of seven lasers and an automated inspection station, is going to Pratt & Whitney to primarily drill holes in various types of turbine blades. The lasers will be linked together with robot guided vehicles and robots.

Some other recent advances in laser products will make justification increasingly easier.

The Wiedemann Div., Warner & Swasey, a Cross & Trecker Co., King of Prussia, Pa., for example, gives users of its Centrum laser system (using a Spectra Physics CO_2 laser) the option of using a PC-based CAD system to streamline contouring and cutting. A further option lets an electronic tablet and pen convert drawings, blueprints, and existing parts directly into machine programs.

ILM has introduced a precision laser driller that has the ability to measure the diameter of a hole in real time during the drilling operation and adjust that drilling action accordingly.

New developments by laser companies and new awareness by process engineers is drawing manufacturing and the laser closer. It will be several years, however, before the period of adjustment yields the happy marriage envisioned by many. □

COPPER FORESEES LESS RED INK

Despite their troubles, copper producers remain optimistic about a turn-up in demand and a chance for much-needed higher prices.

BY ROBERT REGAN

The U.S. copper producers had a lot to look forward to coming into 1986. Interest rates were coming down, the dollar was dropping and so were oil prices.

At the halfway mark they were still waiting for it all to fall in place. Copper prices were on the defensive, import pressures were persisting and there was the seasonal slowdown still to get through.

And yet the producers, perhaps hardened by a series of false starts on the hedge markets, remain optimistic about a turn-up in demand and a chance for much-needed higher prices.

One comforting thought that has crossed the minds of more than a few industry executives is that there wasn't any significant inventory buildup by consumers in front of this year's round of wage negotiations. That means no wait for an inventory workdown.

As G. Robert Durham, president of Phelps Dodge Corp., explained in an interview, "consumers were practically living off the tailgates of our trucks in the first half. They had no inventory to speak of and they can't have much now."

This year was something of a pattern-breaker for the copper industry. Instead of the hedge buying that preceded several earlier triennial wage bargaining rounds, producer shipments were running about 7 pct off the 1985 pace (with some of the difference taken up by imports) and there were no lengthy work stoppages.

Asked what happened to the gains anticipated from the lower dollar, lower oil prices and lower interest rates, Phelps Dodge Chairman George Munroe said with a wry chuckle, "I don't really know. We expected to see something on the consumption side, but we've learned to wait and we still have expectations."

The Phelps Dodge executives said one handicap in the first half was a dearth of trading interest on the hedge markets. Asked if there was a bit of nostalgia for the speculators and volatility, Mr. Munroe said: "You could put it that way if you want to. They certainly have been quiet. Open interest is way down, there's no inflation to speak of, and there are other things the speculators are more interested in."

Ronald J. Vance, vice president, marketing for Newmont Mining Corp., explained that the copper producers were in large part responsible for the consumers' ability to sidestep the inventory-building chore.

"We had a strange situation this time," he said. "We, and other producers too, were saying to the customer 'we will get every pound of copper possible to produce by July 1 to you—or where you will be able to get it—by July 1.' Some of us were also saying operations would continue somehow even if there was a strike.

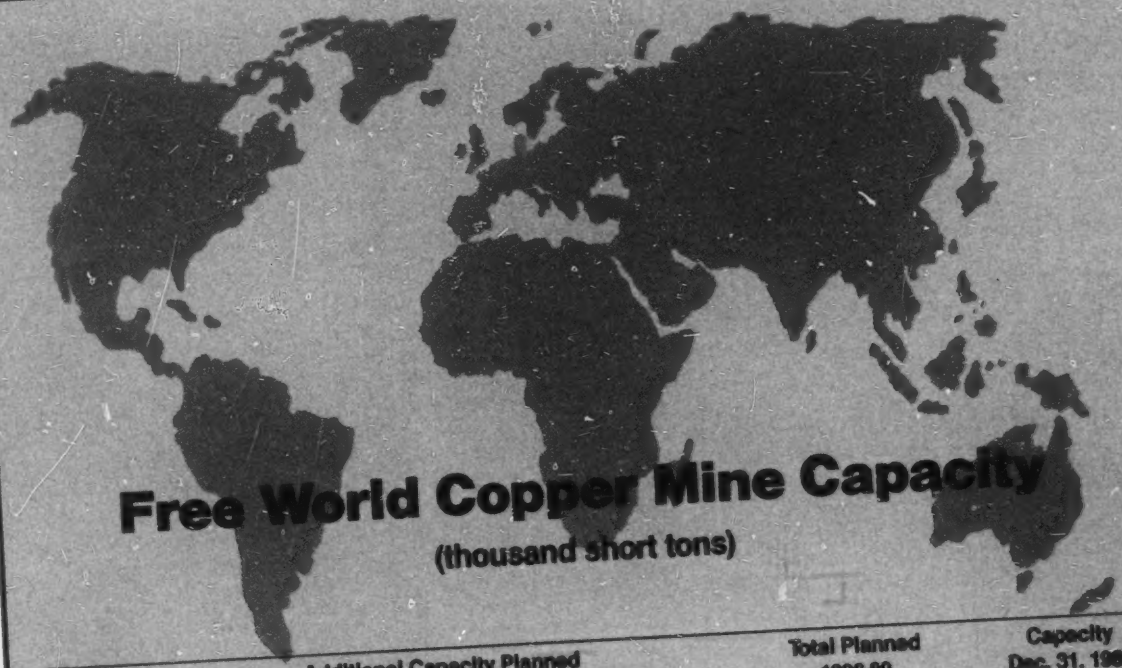
"So, very few of them, if any of them at all, put much extra copper by."

Was the idea to keep them away from imports?

"Well, that, too—but did it? It also was to keep them from going to the other guy. The consumers have gotten quite used to the idea that, when they want copper, all they have to do is pick up the phone. Somebody's always had it ready for them—producers, dealers, exporters—so they weren't that anxious this year... thank goodness."

Copper shipments by the U.S. refineries were down almost 7 pct in the first half, according to the American Bureau of Metal Statistics. ABMS also reported that refined copper imports were up nearly 52 pct in the first third of the year. Chile was the largest supplier, but Canada was close behind.

Brian O'Shaughnessy, senior vice president, marketing for Inspiration Resources Corp., said there had been all sorts of arrangements between producers and consumers in the first half, "but I don't think it led to much of



Free World Copper Mine Capacity

(thousand short tons)

Area/Country	Additional Capacity Planned 1986	1987	1988	1989	Total Planned 1986-89	Capacity Dec. 31, 1989
North America						
United States	35	40	(20)	—	55	1,857
Canada	13	14	—	—	27	1,011
Mexico	65	—	—	—	65	400
Total	113	54	(20)	—	147	3,268
South America						
Chile	25	130	100	165	420	1,920
Peru	(15)	—	—	—	(15)	480
Other	—	—	—	—	—	80
Total	10	130	100	165	405	2,480
Africa						
Zambia	50	—	—	—	50	720
Zaire	—	—	—	—	—	600
S. Africa	(30)	—	—	—	(30)	205
Other	—	—	—	—	—	155
Total	20	—	—	—	20	1,680
Asia						
Philippines	—	—	—	—	—	430
Indonesia	—	—	—	—	—	100
Iran	—	—	—	—	—	80
Japan	—	—	—	—	—	50
Other	—	—	—	—	—	180
Total	—	—	—	—	—	840
Western Europe	—	12	75	—	87	507
World Total	134	186	210	140	670	9,256

Source: American Bureau of Metal Statistics/Phelps Dodge Corp.

a physical buildup at consumer plants."

Near-Term Prospects

As for copper's near-term and mid-term prospects, he said: "Basically, I think it's going to have a lot to do with the general business recovery. If it has another year to run, well, fine and dandy and I don't think copper prices in the mid-70¢ a lb range would be out of line. If it falters, then things could get a bit tough."

Mr. O'Shaughnessy said copper's fundamentals are positive "and more copper will have been used than was produced in every quarter this year except the third quarter—and that will go for early 1987, too."

Asked if recent poor projections for capital spending don't pose a problem for copper, he said: "That's for the U.S., but there is a larger picture. I think capital spending is up elsewhere. It's true the U.S. projection is no positive factor—unless it prompts the Federal Reserve to drop the discount rate."

Newmont's Mr. Vance said of the downward revisions in U.S. capital spending plans "who could be happy about that? It's an important market for copper, but isn't it important to know who is cutting back?"

The U.S. Commerce Department's latest quarterly survey of capital spending for this year found that U.S. industry plans to spend 2.5 pct less than it spent in 1985, after allowing for inflation. That decline, according to the department's analysts, was marked by "severe weakness in the energy sector."

Mr. Munroe of Phelps Dodge said he didn't think capital spending would be down in the general manufacturing area. "I'd like to see better capital spending numbers and maybe we will. It's just taking longer than we had hoped or expected. But I think the stock market has been saying something to us. It seems to be saying business generally is holding up and maybe picking up a bit."

Mr. Durham, who suceeds Mr. Munroe as CEO upon his (Mr. Munroe's retirement next February, chimed in with the observation that "the copper market is close to balance and there isn't much downward room, pricewise."

(At the time, hedge market values and some producer prices were sagging in the wake of the Noranda Copper strike settlement and the first blushes of agreements on terms for new wage pacts by U.S. producers.)

Returning to the lowered capital spending projections, Mr. Munroe said "maybe those numbers will say to the Fed that a further interest rate cut wouldn't be harmful and, if that happens, it should draw some response in the capital spending sector."

The copper producers, unlike many of their competitors, 'have been very complacent about the end uses of copper. We produce it, but we don't promote it.'

The Phelps Dodge executives said the emerging picture of labor peace didn't necessarily mean 1986 domestic copper production would be higher than might have been anticipated earlier this year. There had been some speculation that busier work schedules might be offered to help win the deep pay cuts the companies were seeking.

Labor Settlements

The settlements announced early in July covered Asarco, Inc., Kennecott Corp. and Newmont.

The focus of the bargaining this time was how big the pay cuts would be. It all contrasted sharply with the 1971-80 period, when the bargaining centered on how big the pay boosts and cost-of-living allowances (colas) would be—and when management and labor usually arrived at terms after wide, inventory-clearing strikes that usually were preceded by bouts of inventory building.

In the 1983 round, labor singled out Phelps Dodge for special attention and the lengthy, bitter struggle ended with decertification.

Asked if he thought there would be an attempt to re-organize the company's operations, Mr. Munroe said: "Right now, they would have a tough time of it.

"I don't want to say 'never' to the unforseeable future," he added. "It's possible, of course, and it could be a different union. Who knows?"

Mr. Durham added that "right now, we have a highly motivated workforce. I would say the company is pretty comfortable. Things are not so bad for us because we've got production costs down and business isn't that bad, considering the season. If we get a pickup this fall, fine. There's nothing like improving your rate of return—but we are comfortable with things as they are and we put a lot of work into getting into that condition."

Phelps Dodge had been in the black for five straight quarters and Mr. Munroe said the second quarter would make it six. Last year's mine production topped the company's 1979 record by 20 pct.

Phelps Dodge's gradual turnaround has enabled it to pay down a sizable portion of a heavy long term debt load and pull its revolving credit debt down to zero. This, plus a substantial tax-loss carryforward, has the company actively looking for an acquisition possibility.

Mr. Durham said there is no thought of moving away from copper. The goal is a business not too distant from Phelps Dodge's own mining, engineering and basic industry background. (Cont. on p.49)

"It's got to have a cycle different from copper's and it's got to have a good management staff because our own is pretty lean and there's no pretending we have enough in-house talent to handle another business," he said.

Mr. Munroe added that the door hasn't been closed on a copper acquisition. He said some potential properties have been examined but that was about as far as things had gotten.

Phelps Dodge sold a 15 pct interest in its Morenci, Ariz., mine to the Sumitomo interests last February and signaled plans to sell another 15 pct later on. Talks were broken off with one potential buyer in mid-June and discussions have begun with another potential buyer.

Mr. Munroe declined to identify the company beyond stating that, as was the case earlier, it is a foreign company but not Japanese.

Late last year, Phelps Dodge doubled the capacity of its solvent-extraction, electrowinning facility at Tyrone, N.M., to 35,000 tons a year. Next step is a similar unit for the Morenci, Ariz., mine that will raise capacity of the low-cost system to 80,000 tons a year. Mr. Munroe said the process could be taken up as high as 20 pct of the company's total copper output.

Although there has been some speculation that the process could be a low-priced admission to the copper business, Mr. Munroe said this was unlikely. "There are already some small units, but it's not just something that can be set up anywhere—you've got to have the dumps," he said.

Defending Applications

Getting a better grip on wage and production costs is only part of the survival struggle for the U.S. companies. There also is the matter of defending applications hard-pressed by other materials, improving the grip on the home market and, admittedly far down the pike, expanding copper usage.

Back in 1983, the copper industry worldwide had a 200,000 metric tons a year market in automobile radiators.

'Consumers were practically living off the tailgates of our trucks in the first half. They had no inventory to speak of and they can't have much now.'

G. Robert Durham,
president of Phelps Dodge Corp.

Two years later, according to recent calculations by the International Copper Research Association (INCRA), aluminum's penetration had reached 80 pct in Western Europe, 32 pct in the U.S. and 4 pct in Japan.

As INCRA President William H. Dresher put it in a position paper presented to the copper producers: "With the intensity of the pressure of the aluminum industry today, it is extremely important that the means be found to defend copper's position in this market."

Mr. Dresher detailed a number of technical projects being carried out by INCRA and the Copper Development Association (CDA) to keep the copper/brass radiator competitive.

But, besides INCRA's design-oriented and CDA's manufacturing-oriented programs, two other steps are necessary, he said.

One is to convince the automobile companies and the radiator manufacturers that a superior copper/brass radiator can be built. It would involve direct contact with design and engineering people in the automotive and radiator fields, participation in seminars devoted to auto radiator technology, and support for manufacturers either wishing to upgrade their copper/brass radiators or to switch from aluminum.

The second step, Mr. Dresher said, would involve working with the brass mills to assist them to meet specifications for lighter weight radiators and keeping them updated on technological concepts of radiator design and manufacture.

The catch is that "both of these steps are beyond the budgetary and manpower capabilities of INCRA and the CDA today," Mr. Dresher said.

Sentiments of a roughly similar nature were expressed by Tim Evans, manager of trading for Inspiration Consolidated at an American Copper Council meeting in San Diego earlier this year.

"If the U.S. copper producers are not to be squeezed out of the market by capacity expansions abroad, they must either lower costs below the range where currency devaluation can hurt them—or do something to reverse the declining use of copper.

"While we do have INCRA and CDA fighting a rearguard holding action, much more could be done, especially by the producers on a more competitive basis."

Mr. Evans said the copper producers, unlike many of their competitors, "have been very complacent about the end uses of copper. We produce it, but we don't promote it. It is DuPont, not J.C. Penney, that spends millions promoting synthetic fibers; it is Georgia-Pacific, not A&P, that promotes paper bags; and it is Alcoa, not Coca-Cola that promotes aluminum cans. When are we going to discover advertising?"

The main difference in the automobile radiator market, he said, "was the sales job." □

PRICE & PRODUCTION DATA

(Effective September 22, 1986)

Steel production by districts, thousands of tons (000 omitted)

	Last Week	Two Weeks Ago	Month Ago	Year Ago
Northeast Coast	144	145	134	169
Pittsburgh	168	165	168	154
Youngstown	114	106	103	97
Lake Erie	99	104	103	143
Detroit	132	132	135	144
Chicago	342	334	322	476
Midwest	131	118	141	161
Southern	135	139	138	181
Western	41	40	40	69
U.S. Production	1,306	1,283	1,284	1,594

Source: American Iron & Steel Institute

Lake Superior Ore Prices

51.50% Fe Natural delivered lower Lake ports unless otherwise stated. Rail transportation, handling and unloading may be charged to buyer. Coarse ore 80¢ premium.

Pellets (per iron unit natural)	gross-ton 58.0*
Pellets (per iron unit natural)	gross-ton 59.4**
Pellets (per iron unit natural)	gross-ton 72.5-86.9***
Mesabi, regular-unscreened	gross-ton 32.53
Mesabi, non-bessemer	gross-ton 30.03-31.53

*58.0¢—Mineral Services, Inc. as of 8/13/85. **59.4¢—Inland Steel Mining, 1/1/85 sold Pickands Mather. 8/1/85 delivered hold of vessel, upper Lake ports. ***72.5¢—U.S. Steel as of 8/16/85. 86.9¢—Oglebay Norton 3/25/82, Hanna Mining and Cleveland Cliffs, 2/26/82.

STEEL PRODUCTION, COMPOSITE PRICES

(Effective September 22, 1986)

U.S. Steel Production	Last Week	Two Weeks Ago	To Date 1986	To Date 1985
Net tons, in thousands	1,306	1,283	60,642	63,471
Capability Utilization Rate	53.9	52.9	65.5	65.8

Composite Prices	This Week	Week Ago	Month Ago	Year Ago
Finished Steel Base* (¢/lb.—eff. 8/31/86)	24.951	24.951	24.850	27.582
Pig Iron** (Net ton=2000 lbs.)	$213.00	$213.00	$213.00	$213.00
Scrap No. 1 hvy.*** (Gross ton=2240 lbs.)	$ 73.83	$ 74.50	$ 75.17	$ 72.17
No. 2 bundles	$ 51.17	$ 52.17	$ 53.83	$ 53.17

Scrap Comparison (Gross Ton)				
No. 1 steel, Pittsburgh	$ 76.50	$ 76.50	$ 76.50	$ 75.50
No. 1 steel, Philadelphia	71.50	73.50	73.50	68.50
No. 1 steel, Chicago	73.50	73.50	75.50	72.50
No. 1 bundles, Detroit	72.50	72.50	72.50	69.50
Low Phos., Youngstown	74.50	74.50	74.50	70.50
No. 1 mach'y cast, Pgh	74.50	74.50	74.50	71.50
No. 1 mach'y cast, Phila	93.50	93.50	93.50	92.50
No. 1 mach'y cast, Chi.	103.50	103.50	105.50	99.50

*Finished Steel Composite. Weighted index of steel bars, shapes, plates, wire, rails, black pipe, hot and cold rolled sheets and strip.
**Pig Iron Composite. Based on average prices for basic and foundry pig iron at representative producing points within the U.S.
***Steel Scrap Composite. Average of No. 1 hvy. melting steel scrap and No. 2 bundles delivered to consumers at Pittsburgh, Philadelphia and Chicago.

NONFERROUS PRICES

(Effective September 22, 1986) Prices obtained in trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated.

Primary Metal Prices

(cents per lb.)	current price	last price	date of change
Aluminum (LME)	52.54	52.07	9/22/86
Copper (C)	65.00	64.00-65.00	9/22/86
Lead	23.50	22.50-23.00	9/22/86
Magnesium Ingot	153.00	148.00	12/9/85
Nickel (LME)	169.00	166.84	9/22/86
Zinc	44.00	41.00-44.00	7/30/86

ALUMINUM: Avg. for last week & previous week. COPPER (C): cathode. LEAD: common grade. MAGNESIUM: 99.8% pig delivered. NICKEL: Avg. for last week & previous week. ZINC: high grade.

Antimony, American Laredo, Texas	$2.00
Beryllium-aluminum 5% Be, per lb. contained Be	$248.00
Beryllium-copper, per lb. cont. Be	$144.00
Beryllium 97% powder 200	$197.00
Cadmium, ton lots	$1.00
Calcium, ton lots, crown	$3.92
Chromium, 99.5% electro	$4.62
Cobalt, 99%, cathode	$11.70
Gold, per troy oz.	$435.50
Indium, per troy oz.	$2.65
Iridium, per troy oz.	$415.00
Magnesium sticks, 10,000 lbs.	$2.02
Mercury, per 76-lb., f.o.b. N.Y.	$195.00-210.00
Molybdenum, lb. tech. moly oxides, 20 lb. 'MO can	$3.25
Palladium, per troy oz.	$141.00
Platinum, per troy oz.	$610.00
Rhodium, per troy oz.	$1,235.00
Silver ingots, per troy oz.	$6.00
Titanium sponge, melt grade	$3.40-3.55
Tungsten powder, hyd red.	$9.50-9.85
Vanadium	$6.00
Zirconium sponge	$12.00-17.00

(Per lb. unless otherwise noted)

Straits Tin Price

(U.S. cents per lb. EX SMELTER, based on daily market in Kuala Lumpur in Malaysian dollars per kilo.)

September 15—N.A. September 18—N.A.
September 16—N.A. September 19—N.A.
September 17—N.A.

Scrap Prices
Brass Mill Scrap

(Cents per lb.; over 20,000 lbs. add 1¢ per lb.)

	Solids	Turnings
Copper	56	51
Yellow brass	50	49½
Red brass	51	47
Comm. bronze	52½	47½
Mang. bronze	41½	40½
Free cutting rod ends	49	48

Custom Smelters Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	53
No. 2 copper wire	44
Light copper	36

Ingot Makers Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	49
No. 2 copper wire	40
Light copper	32
No. 1 composition	45
No. 1 comp. turnings	44
Hvy. yellow brass solids	30
Hvy. yellow brass turnings	25
Radiators	34

Aluminum		
New mixed clips	35	— 36
Old sheet	33	— 34
Old cast	33	— 34
Clean dry borings	34	— 35

Dealers' Scrap

(Dealers' buying price f.o.b. New York in cents per pound)

Aluminum		
Segregated clippings	28	— 29
Mixed I.C. clips	26	— 27
Old sheets and cast	23	— 24
Borings and turnings	19	— 20
Duraluminum clippings	24	— 25

Copper and Brass		
No. 1 copper wire	45	— 47
No. 2 copper wire	36	— 37
Light copper	31	— 33
Radiators	26	— 27
No. 1 composition	36	— 37
No. 1 composition turnings	34	— 35
Cocks and faucets	27	— 28
Clean heavy yellow brass	25	— 26
Brass pipe	27	— 28
New soft brass clippings	37	— 39

Lead		
Heavy soft lead	5	— 7
Whole batteries	1	— 3
Type metal	15	— 17
Electrotype	13	— 14

Nickel		
Nickel solids	105	—115
Nickel rod ends	105	—115
Nickel sheets, clips	105	—115
Nickel turnings	25	— 35

Zinc		
New zinc clippings	16	— 17
Old diecast zinc	12	— 13

EFFECTIVE SEPTEMBER 22, 1986

(Effective September 22, 1986) Prices obtained or trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated. Prices are the opinions of Iron Age editors and correspondents, based on contacts with dealers, brokers, generators and users in the industry on the effective date listed above.

Ferrous Scrap Prices

Pittsburgh

No. 1 hvy. melting	$ 76.00 to	$ 77.00
No. 2 hvy. melting	66.00 to	67.00
No. 1 dealer bundles	93.00 to	94.00
No. 1 factory bundles (auto)	94.00 to	95.00
No. 2 bundles	45.00 to	46.00
No. 1 busheling	89.00 to	90.00
Machine shop turnings	8.00 to	9.00
Shoveling turnings	43.00 to	44.00
Cast iron borings	42.00 to	43.00
Low phos. punchings plate	104.00 to	105.00
Heavy turnings	66.00 to	67.00
No. 1 RR hvy. melting	86.00 to	87.00
Rails, 2 ft and under	96.00 to	97.00
Scrap rails, random lgth	83.00 to	84.00
RR specialties	96.00 to	97.00
No. 1 machinery cast	74.00 to	75.00
Cupola cast	67.00 to	68.00
Heavy breakable cast	30.00 to	31.00
Stainless		
18-8 bundles and solids	495.00 to	505.00
18-8 turnings	395.00 to	405.00

Chicago

No. 1 hvy. melting	$ 73.00 to	$ 74.00
No. 2 hvy. melting	68.00 to	69.00
No. 1 dealer bundles	87.00 to	88.00
No. 1 factory bundles (auto)	91.00 to	92.00
No. 2 dealer bundles	57.00 to	58.00
No. 1 busheling	83.00 to	84.00
Shredder scrap	81.00 to	82.00
Machine shop turnings	26.00 to	27.00
Mixed borings and turnings	20.00 to	21.00
Shoveling turnings	27.00 to	28.00
Cast iron borings	40.00 to	41.00
Low phos. forge crop	94.00 to	95.00
Low phos. punchings plate 1/4 in. and heavier	111.00 to	112.00
Low phos. 2 ft and under	106.00 to	107.00
No. 1 RR hvy. melting	76.00 to	77.00
Scrap rails random lgth	79.00 to	80.00
Reroller rails	100.00 to	101.00
Rails, 2 ft and under	96.00 to	97.00
RR couplers and knuckles	81.00 to	82.00
RR car axles	106.00 to	107.00
No. 1 machinery cast	103.00 to	104.00
Cupola cast	90.00 to	91.00
Stove plate	99.00 to	100.00
Steel car wheels	87.00 to	88.00
Stainless		
18-8 bundles and solids	465.00 to	475.00
18-8 turnings	370.00 to	380.00
430 bundles and solids	125.00 to	135.00
430 turnings	85.00 to	95.00

Philadelphia

No. 1 hvy. melting	$ 70.00 to	$ 73.00
No. 2 hvy. melting	62.00 to	65.00
No. 1 dealer bundles	82.00 to	85.00
No. 2 dealer bundles	49.00 to	52.00
No. 1 busheling	82.00 to	85.00
Shredder scrap	84.00 to	87.00
Machine shop turnings	24.00 to	27.00
Mixed borings and turnings	24.00 to	27.00
Shoveling turnings	37.00 to	40.00
Low phos. 5 ft and under	79.00 to	82.00
Low phos. 2 ft punchings	93.00 to	96.00
Electric furnace bundles	90.00 to	93.00
RR specialties	79.00 to	82.00
Rails, 2 ft and under	96.00 to	99.00
Cupola cast	84.00 to	87.00
Heavy breakable cast	53.00 to	56.00
No. 1 machinery cast	92.00 to	95.00

Detroit

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 54.00 to	$ 55.00
No. 2 hvy. melting	53.00 to	54.00
No. 1 dealer bundles	72.00 to	73.00
No. 2 bundles	35.00 to	36.00
No. 1 busheling	70.00 to	71.00
Drop forge flashings	44.00 to	45.00
Machine shop turnings	26.00 to	27.00
Mixed borings and turnings	7.00 to	8.00
Shoveling turnings	26.00 to	27.00
Cast iron borings	22.00 to	23.00
Heavy breakable cast	32.00 to	33.00
Mixed cupola cast	47.00 to	48.00
Automobile cast	71.00 to	72.00
Stainless		
18-8 bundles and solids	450.00 to	460.00
18-8 turnings	330.00 to	340.00
430 bundles and solids	115.00 to	125.00

Youngstown

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 57.00 to	$ 58.00
No. 2 hvy. melting	55.00 to	56.00
No. 1 dealer bundles	75.00 to	76.00
No. 2 dealer bundles	33.00 to	34.00
Machine shop turnings	20.00 to	21.00
Shoveling turnings	20.00 to	21.00
Low phos. plate	74.00 to	75.00
Electric furnace bundles	63.00 to	64.00
Galvanized bundles	60.00 to	61.00

Cleveland

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 55.00 to	$ 56.00
No. 2 hvy. melting	53.00 to	54.00
No. 1 dealer bundles	80.00 to	81.00
No. 1 factory bundles	78.00 to	79.00
No. 2 bundles	31.00 to	32.00
No. 1 busheling	70.00 to	71.00
Machine shop turnings	20.00 to	21.00
Shoveling turnings	20.00 to	21.00
Cast iron borings	20.00 to	21.00
Cut structural & plates, 5 ft and under	71.00 to	72.00
Cut structural & plates, 2 ft and under	92.00 to	93.00
Low phos. punchings plate	92.00 to	93.00
Foundry steel, 2 ft. & under	54.00 to	55.00
No. 1 RR hvy. melting	60.00 to	61.00
Rails, 2 ft and under	89.00 to	90.00
Rails, 18 in. and under	91.00 to	92.00
No. 1 machinery cast	80.00 to	81.00
Mixed cast	47.00 to	48.00
Stainless		
18-8 bundles	450.00 to	460.00
18-8 turnings	335.00 to	345.00
430 bundles	120.00 to	130.00

Buffalo

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 53.00 to	$ 54.00
No. 2 hvy. melting	43.00 to	44.00
No. 1 busheling	71.00 to	72.00
No. 1 dealer bundles	71.00 to	72.00
No. 2 bundles	32.00 to	33.00
Machine shop turnings	13.00 to	14.00
Mixed borings and turnings	13.00 to	14.00
Shoveling turnings	19.00 to	20.00
Cast iron borings	27.00 to	28.00
Low phos. plate	78.00 to	79.00
Structural and plate, 2 ft and under	79.00 to	80.00
Rails, 2 ft and under	79.00 to	80.00
Scrap rails, random lgth	61.00 to	62.00
No. 1 machinery cast	74.00 to	75.00
No. 1 cupola cast	71.00 to	72.00

St. Louis

No. 1 hvy. melting	$ 70.00 to	$ 71.00
No. 2 hvy. melting	58.00 to	59.00
No. 1 busheling	80.00 to	81.00
No. 1 dealer bundles	82.00 to	83.00
No. 2 bundles	56.00 to	57.00
Machine shop turnings	17.00 to	18.00
Shoveling turnings	21.00 to	22.00
Cast iron borings	27.00 to	28.00
No. 1 RR hvy. melting	79.00 to	80.00
Rails, random length	72.00 to	73.00
Rails, 5 ft and under	86.00 to	87.00
RR specialties	79.00 to	80.00
Cupola cast	66.00 to	67.00
Heavy breakable cast	40.00 to	41.00
Stove plate	85.00 to	86.00
Steel car wheels	85.00 to	86.00
Rerolling rails	99.00 to	100.00
Unstripped motor blocks	49.00 to	50.00

Birmingham

No. 1 hvy. melting	$ 70.00 to	$ 71.00
No. 2 hvy. melting	66.00 to	67.00
No. 1 dealer bundles	70.00 to	71.00
No. 2 bundles	46.00 to	47.00
No. 1 busheling	70.00 to	71.00
Shredder scrap	88.00 to	89.00
Machine shop turnings	23.00 to	24.00
Shoveling turnings	36.00 to	37.00
Cast iron borings	36.00 to	37.00
Electric furnace bundles	67.00 to	68.00
Elec. furnace, 3 ft. & under	70.00 to	71.00
Structural and plate, 2 ft	89.00 to	90.00
Structural and plate, 4 ft	83.00 to	84.00
No. 1 RR hvy. melting	83.00 to	84.00
Scrap rails, random lgth	73.00 to	74.00
Rails, 2 ft and under	90.00 to	91.00
Angles and splice bars	83.00 to	84.00
No. 1 cupola cast	82.00 to	83.00
Unstripped motor blocks	72.00 to	73.00

Cincinnati

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 50.00 to	$ 51.00
No. 2 hvy. melting	49.00 to	50.00
No. 1 dealer bundles	72.00 to	73.00
No. 2 bundles	32.00 to	33.00
Machine shop turnings	9.00 to	10.00
Shoveling turnings	12.00 to	13.00
Cast iron borings	19.00 to	20.00
Low phos. 18 in. and under	77.00 to	78.00
Rails, random length	59.00 to	60.00
Rails, 2 ft and under	75.00 to	76.00
No. 1 cupola cast	64.00 to	65.00
Heavy breakable cast	25.00 to	26.00
Drop broken cast	68.00 to	69.00

New York

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 38.00 to	$ 40.00
No. 2 hvy. melting	31.00 to	32.00
No. 2 dealer bundles	20.00 to	22.00
Mixed borings and turnings	10.00 to	11.00
Machine shop turnings	4.00 to	6.00
Shoveling turnings	10.00 to	12.00
Clean cast, chem. borings	35.00 to	36.00
No. 1 machinery cast	79.00 to	80.00
Mixed yard cast	50.00 to	51.00
Heavy breakable cast	10.00 to	12.00
Stainless		
18-8 prepared solids	420.00 to	440.00
18-8 turnings	320.00 to	340.00
430 prepared solids	90.00 to	100.00
430 solids	75.00 to	85.00

Boston

Brokers buys prices per gross ton on cars

No. 1 hvy. melting	$ 49.00 to	$ 51.00
No. 2 hvy. melting	39.00 to	41.00
No. 1 dealer bundles	50.00 to	52.00
No. 2 bundles	32.00 to	34.00
No. 1 busheling	56.00 to	58.00
Shredder scrap	59.00 to	61.00
Machine shop turnings	12.00 to	14.00
Shoveling turnings	18.00 to	20.00
No. 1 machinery cast	72.00 to	77.00
Mixed cupola cast	44.00 to	46.00
Heavy breakable cast	8.00 to	10.00

San Francisco

No. 1 hvy. melting	$ 40.00 to	$ 42.00
No. 2 hvy. melting	34.00 to	36.00
No. 1 dealer bundles	31.00 to	33.00
No. 2 dealer bundles	20.00 to	21.00
Machine shop turnings	8.00 to	9.00
Cast iron borings	8.00 to	9.00
No. 1 cupola cast	80.00 to	82.00

Los Angeles

No. 1 hvy. melting	$ 34.00 to	$ 36.00
No. 2 hvy. melting	28.00 to	30.00
No. 1 dealer bundles	26.00 to	28.00
No. 2 dealer bundles	16.00 to	18.00
Machine shop turnings	9.00 to	10.00
Shoveling turnings	10.00 to	11.00
Cast iron borings	8.00 to	9.00
Elec. furnace, 1 ft and under (foundry)	67.00 to	69.00
No. 1 cupola cast	72.00 to	74.00

Seattle

No. 1 hvy. melting	$ 60.00 to	$ 62.00
No. 2 hvy. melting	51.00 to	53.00
No. 2 bundles	35.00 to	37.00
No. 1 cupola cast	89.00 to	90.00
Mixed yard cast	80.00 to	82.00

Hamilton, Ont.

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 74.00
No. 2 hvy. melting, cut 2 ft and under	66.00
No. 1 dealer bundles	82.00
No. 2 bundles	58.00
Mixed steel scrap	53.00
Bush. new fact. prep'd	77.00
Bush. new fact. unprep'd	60.00
Machine shop turnings	30.00
Short steel turnings	30.00
Mixed borings and turning	19.00
Cast scrap	97.00

Houston

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 62.00 to	$ 63.00
No. 2 hvy. melting	52.00 to	53.00
No. 2 bundles	33.00 to	34.00
Machine shop turnings	13.00 to	14.00
Crushed turnings	24.00 to	25.00
Shredder scrap	70.00 to	71.00
Cut structural plate, 2 ft and under	88.00 to	89.00
Cut structural plate, 5 ft and under	70.00 to	71.00
Unstripped motor blocks	54.00 to	55.00
Cupola cast	81.00 to	82.00

COMPANIES PAY HIGH PRICE FOR LOW PRICES

August was another month of soft prices for producer goods. Finished goods prices managed a 0.3 pct month-to-month rise. The hike was too weak to make up for a decrease in July, so August prices ended up below the July level.

These prices, through the 12-month period ending at the close of August, were down by 1.8 pct.

As noted on the table here, prices for key metalworking product lines in August flashed more minus and zero-change signs from July than they did pluses. Relatively strong-running prices for capital equipment edged up only 0.1 pct in August.

Price stability at low levels is a sought-for economic goal, of course. But lately, cheers about attaining this goal are becoming muted. Manufacturers are relearning the lesson that competition is tougher in a low price level economy. They can't hike their tags to keep up their earnings.

These tougher times for company profits show up in government aggregate data.

From the second quarter of 1984 to the same period in 1986, producer prices for industrial goods fell by 4.8 pct. This, during a time span when the U.S. economy grew by almost 12 pct.

Economic growth, however, largely because of price softness, did not give a lift to company earnings. Corporate profits, over the above-noted time span where the economy expanded by almost 12 pct, fell by about 3 pct.

Of course, students of economic trends trace these relationships back to what many consider to be square one—soaring imports. It's tough for U.S. producers to post price hikes when foreign goods of all kinds are rolling in with riptide fury.

Latest Month Covered: August 1986

Products	Index Reading For Month (1967 = 100)	Pct Change From Previous Month	Pct Change From Year-Ago Month
Metal Cutting Machine Tools	404.7	+ 0.2	+ 1.7
Metal Forming Machine Tools	441.2	0	+ 1.5
Agricultural Machinery & Equip.	340.3	+ 0.2	+ 0.7
Construction Machinery & Equip.	367.1	+ 0.1	+ 1.3
Oil and Gas Field Machinery	412.2	– 1.6	– 3.0
Industrial Material Handling Equip.	296.9	0	+ 0.5
Pumps, Compressors & Allied Equip.	362.4	+ 0.1	+ 1.5
Mining Machinery & Equipment	380.7	– 0.4	+ 0.2
Mechanical Power Transmission Equip.	347.8	+ 0.1	+ 2.3
Automobiles	232.5	– 0.6	+ 1.9
Motor Trucks—Light	306.3	– 1.6	+ 4.4
Motor Trucks—Heavy	348.0	+ 0.2	+ 4.4
Railroad Equipment	368.0	+ 0.1	+ 0.9
Fabricated Metal Structural Products	317.2	+ 0.4	+ 0.7
Electric Motors	353.3	– 0.1	+ 0.5
Valves & Fittings (Dec. 1982 = 100)	106.9	0	+ 1.6
Ball & Roller Bearings	357.0	0	+ 0.8
Foundry & Forge Shop Products	361.9	– 0.4	– 0.7
Heating Equipment	269.0	+ 0.1	+ 3.1
Plumbing Fixtures & Brass Fittings	322.7	– 0.3	+ 3.0
Metal Containers	362.5	+ 0.1	+ 1.3
Internal Combustion Engines	354.0	– 0.1	+ 2.0

Data based on U.S. Labor Dept.'s Producer Price Index